MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

PPH0135 – ELECTRICITY AND MAGNETISM
(Foundation in Engineering)

29 FEBRUARY 2020
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 7 pages excluding the cover page with 5 questions and appendices.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [10 MARKS]

(a) In Figure Q1(a) below, the net electrostatic force acting on point charge B is zero.

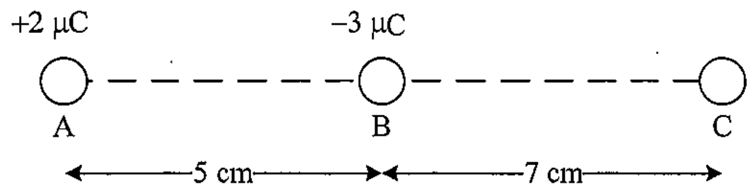

Figure Q1(a)

(i) What is the sign of point charge *C*? Explain your answer. [1 mark]

(ii) Find the magnitude of point charge *C*. [3 marks]

(iii) If the distance between point charges *B* and *C* is reduced to 5 cm, in which direction will point charge *B* accelerate? Explain your answer. [1 mark]

(b) Figure Q1(b) shows a combination of capacitors in a circuit. Each capacitor has a capacitance of 4.0 μF.

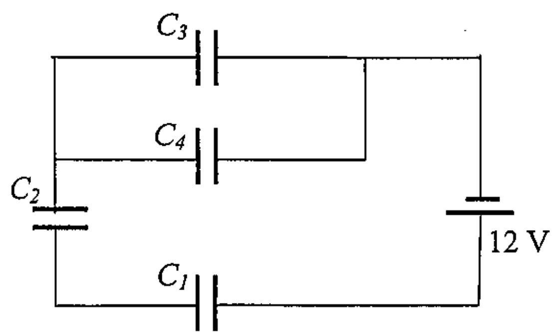

Figure Q1(b)

(i) Determine the equivalent capacitance of the circuit. [1½ marks]

(ii) Calculate the amount of charge stored in C_2. [1 mark]

(iii) Determine the voltage across C_3. [1½ marks]

(c) What are the two factors that can increase the capacitance value of a parallel-plate capacitor? [1 mark]

Continued...

QUESTION 2 [10 MARKS]

(a) Calculate the diameter of a 2.0 cm length of tungsten filament in a small light bulb if its resistance is 0.05 Ω.
[Given: resistivity of tungsten is 5.6×10^{-8} Ω.m]

[2 marks]

(b) By using Kirchhoff's rule, find each of the currents I_1, I_2, and I_3 for the circuit in Figure Q2(b).

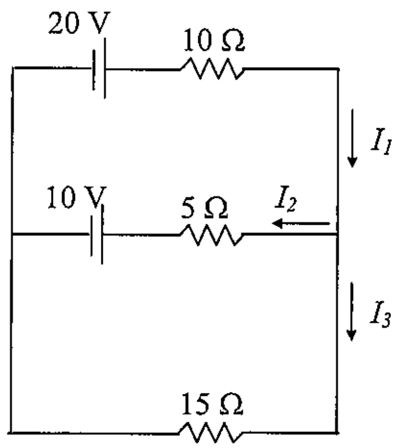

Figure Q2(b)

[5 marks]

(c) Find the equivalent Thevenin's resistance (R_{TH}) and the equivalent Thevenin's Voltage (V_{TH}) across resistor $\boldsymbol{R_1}$ for the circuit shown in Figure Q2(c) below.

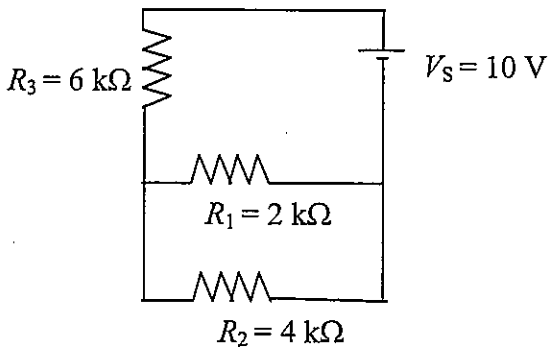

Figure Q2(c)

[3 marks]

Continued...

QUESTION 3 [10 MARKS]

(a) A straight wire has a length of 130 m. This wire carries 50 A current and makes an angle of 70° to the Earth's magnetic field of 0.5×10^{-4} T. What magnitude of force is exerted on this wire?

[2 marks]

(b) An electron is traveling horizontally to the east in a vertically upward magnetic field. The strength of the magnetic field is 0.48 T and the speed of the electron is 2.8×10^{4} m/s.

(i) Find the magnitude of the force on this electron. [2 marks]

(ii) Determine the direction of the force on this electron. [1 mark]

(c) (i) Discuss the effect on the compass due to the magnetic field caused by dc current in the wires.

[2 marks]

(ii) Discuss the effect on the compass due to the magnetic field caused by ac current in the wires.

[1 mark]

(d) A 15.0 cm long solenoid, 1.55 cm in diameter is to produce a field of 0.4 T at its center. If the maximum current is 5.0 A, how many turns of wire must the solenoid have?

[2 marks]

Continued...

QUESTION 4 [10 MARKS]

(a) Consider a basic AC circuit with the maximum voltage V_{max} = 250 V. This source is connected to a 125 Ω resistor. Calculate the rms voltage and rms current in the resistor.

[2 marks]

(b) A series RLC AC circuit has frequency f = 75.0 Hz, inductance L = 0.750 H, resistance R = 350 Ω, capacitance C = 2.85 μF and maximum voltage V_{max} = 160 V.

(i) Determine the impedance of the circuit. [3 marks]

(ii) Find the maximum current in the circuit. [1 mark]

(iii) Calculate the phase angle. [1 mark]

(iv) Find the maximum voltage across the resistor, inductor and capacitor.

[3 marks]

Continued...

QUESTION 5 [10 MARKS]

(a) Discuss the differences between n-type and p-type semiconductors in terms of their impurity, majority carrier and minority carrier.

[4 marks]

(b) Calculate the average value of a full-wave rectified voltage with a peak value of 175 V.

[1 mark]

(c) Figure Q5(c) shows a silicon transistor circuit. Find I_B, I_E, and I_C in Figure Q5(c), given that V_{BB} = 3V, R_E = 2.0 kΩ and V_{CC} = 20 V. Assume that α_{DC} = 0.96 and β_{DC} = 24.

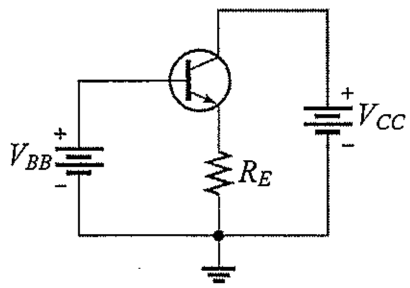

Figure Q5(c)

[5 marks]

Continued...

APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N·m^2/kg^2
Gas constant	R	8.314 J/K·mol
Hydrogen ground state	E_o	−13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J·s
Speed of light in vacuum	c	3.0×10^{8} m/s
Rydberg constant	R_H	1.097×10^{7} m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^{9} N m^2/C^2
Permittivity of free space	ε_o/κ_o	8.85×10^{-12} C^2/N·m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:
One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Continued...

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 n I$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L\frac{dI}{dt}$$

$$\xi = -M\frac{dI}{dt}$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x}\right) I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_o N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$P_t = I_{rms} V_{rms}\cos\phi$$

$$P_r = V_{rms} I_{rms}\sin\phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0[1 + \alpha(T - T_0)]$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA\sin\theta$$

$$U = \frac{1}{2}LI^2$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$V_H = Bvd$$

$$V = V_{max}\sin\omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T}\right) V_S$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B.dl = \mu_o I$$

$$d\mathbf{B} = \frac{\mu_o I}{4\pi}\frac{d\ell \times \hat{\mathbf{r}}}{r^2}$$

$$\Phi_B = BA\cos\theta$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

End of Paper